



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación



Benefit of assimilating dust observations: **MONARCH experience**

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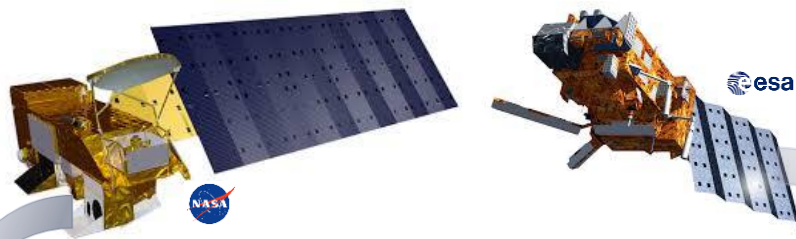
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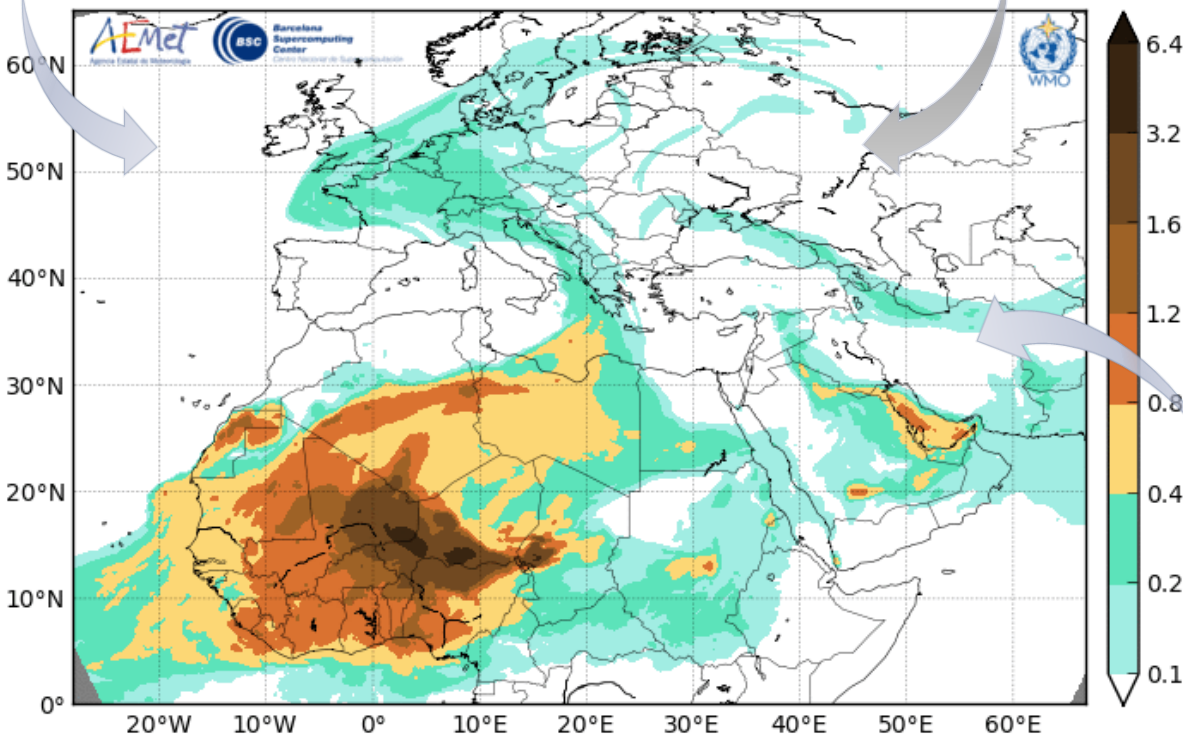
02/04/2019

ACTRIS-2 Final General Meeting

Constraining Mineral Dust Simulations with Observations

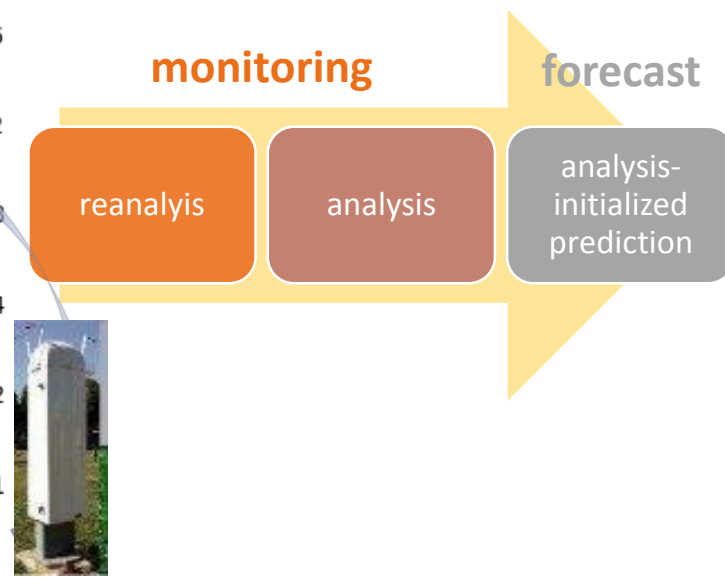


Barcelona Dust Forecast Center - <http://dust.aemet.es/>
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 09 APR 2018 Valid: 12h 09 APR 2018 (H+00)



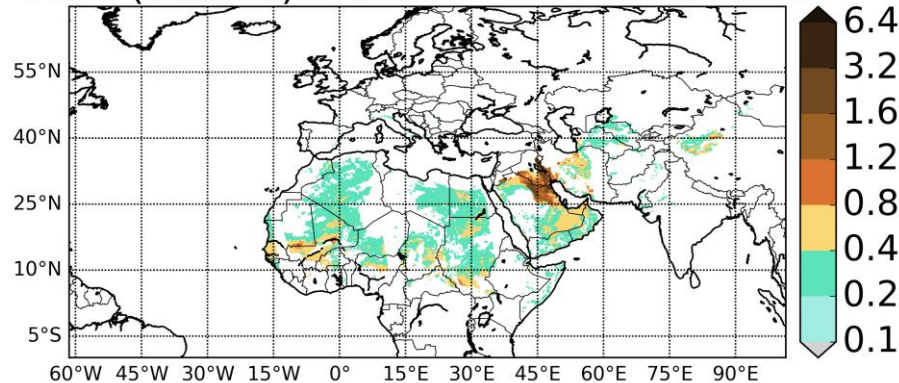
Model simulations and observations are combined to obtain the 'best' estimate of current atmospheric conditions (dust analysis)

- *useful to initialise models and improve predictions*
- *used to produce reanalysis*



Assimilation of dedicated satellite dust observations: MODIS sensor

AOD (550nm) MODIS DB L3 2012030112

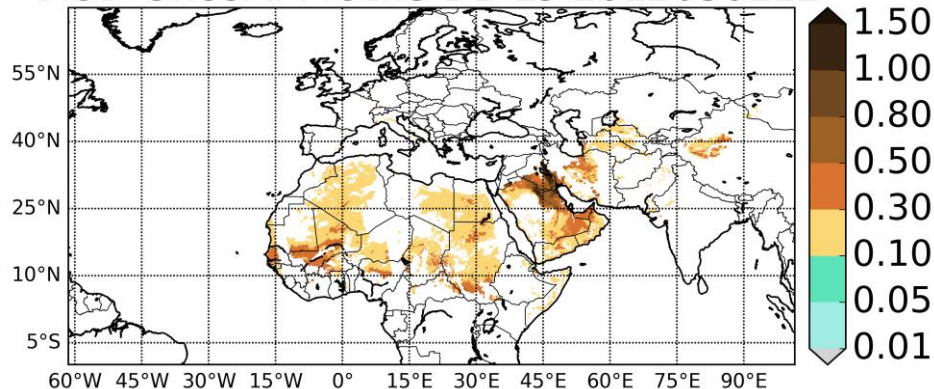


MODIS Deep Blue Coarse AOD

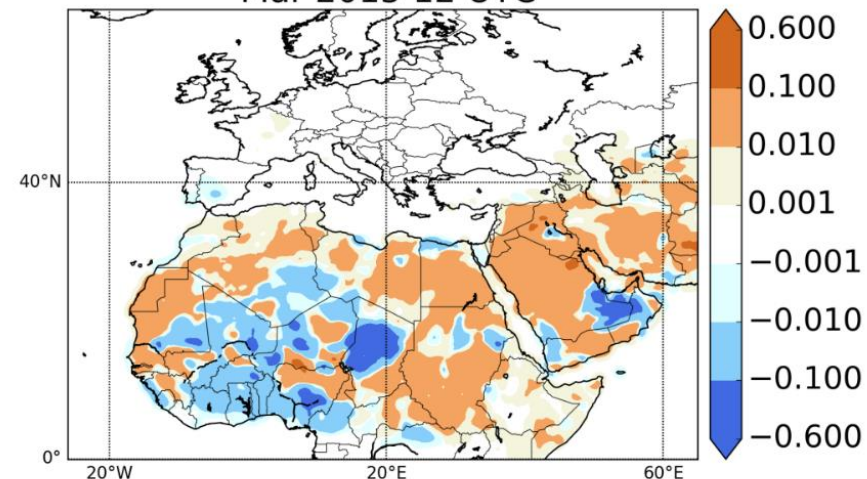


- AE, ω filter, coarse AOD retrieval
- highest quality flag (Ginoux et al., 2012; Pu & Ginoux 2017)
- uncertainty model based on Sayer et al., 2014

AOD Uncert. MODIS DB L3 2012030112



Dust AOD (550nm) analysis - first guess
Mar 2015 12 UTC



Assimilation of dedicated satellite dust observations: IASI sensor

IMARS



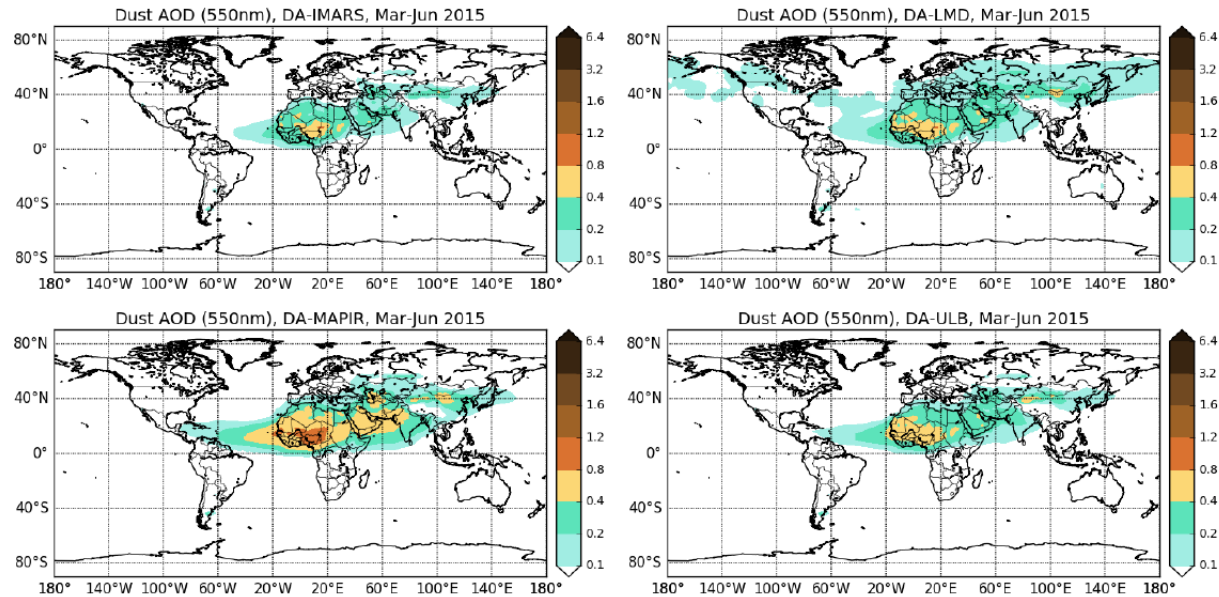
MAPIR



LMD



ULB



IASI dust AOD

- observations available day time and night time, over ocean and over land (desert)
- 10 μm : detection of dust aerosol coarse mode (IR wavelengths and “V” shaped depression of the Brightness Temperature)
- pixel level uncertainty
- suited for long-term evolution



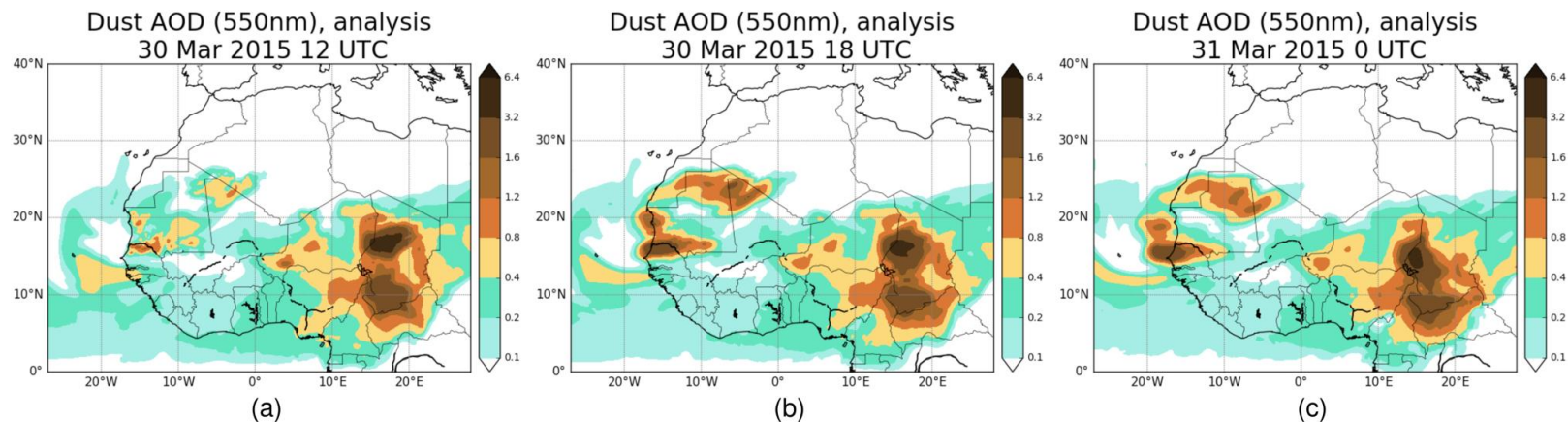
Assimilation of lidar observations: Senegal case study, March 2015

Simulations

- Model simulations from the BSC model (NMMB-MONARCH)
- An ensemble-based DA scheme: LETKF (usage of a flow-dependent background error covariance, performing the analysis locally)
- The ensemble forecast has been designed considering model uncertainties with respect to: surface winds, soil humidity, vertical flux distribution at sources

Observations

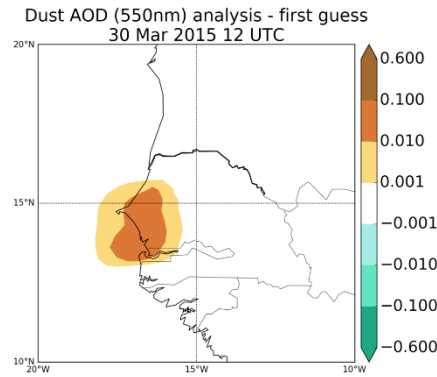
- Multi-wavelength Mie-Raman lidar profile observations processed by the **University of Lille** for the M'bour site outside Dakar



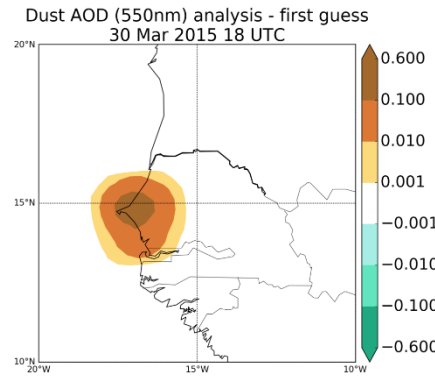
Observational impact through the whole assimilation window
(4D extension of the DA scheme)

Assimilation of lidar observations: Senegal case study, March 2015

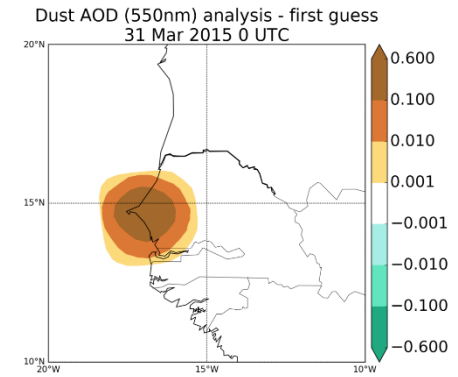
Analysis
increments



(a)



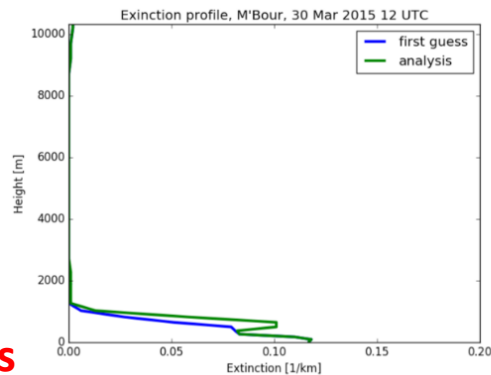
(b)



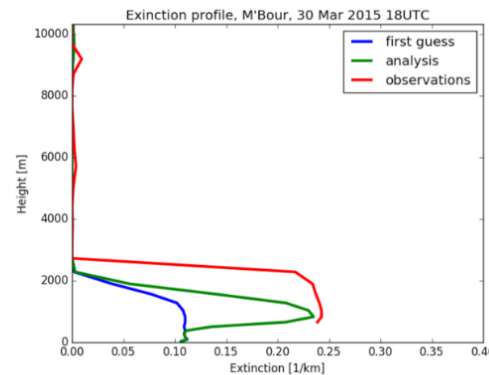
(c)

Correction of an underestimation in total column extinction in the model

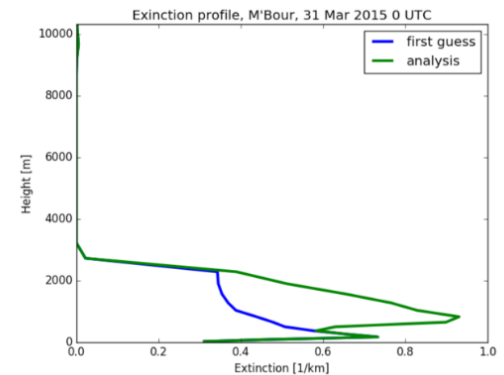
Exinction
profiles for
- ensemble
forecast
- ensemble
analysis
- observations



(a)



(b)



(c)

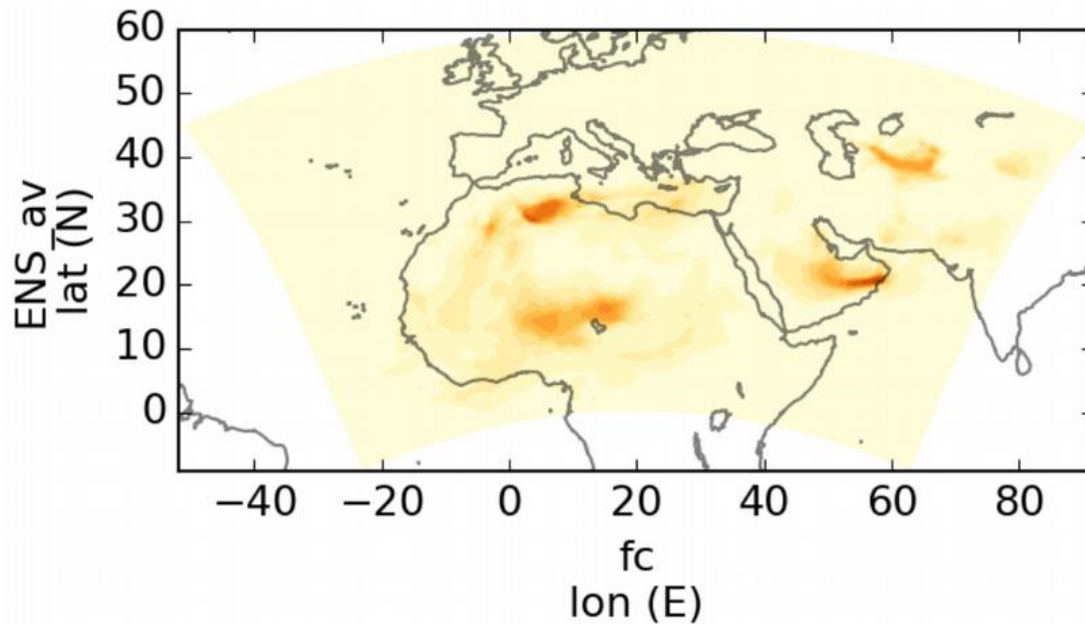
Analysis is closer to the assimilated observations

Assimilation of lidar observations: East Mediterranean case study, April 2017

Event observed by 3 lidar sensors located in Finokalia (Crete), Limassol (Cyprus) and Haifa (Israel) part of the PollyNet (<http://polly.tropos.de/>) system. Data (with uncertainty estimation) processed by **TROPOS**.

Model simulations: $0.33^\circ \times 0.33^\circ \times 40$ levels

Mean ensemble forecast for April 20 18Z

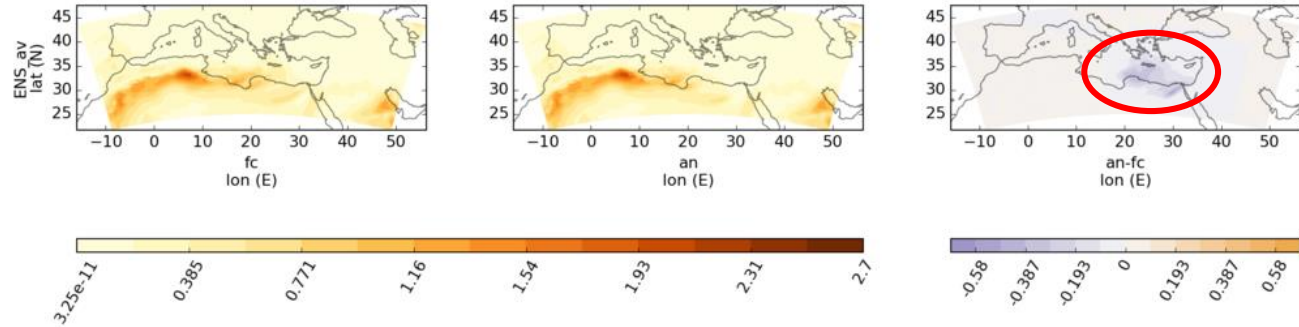


- wider radius of obs influence
- uncertainty estimation $\times 0.5$
- uncertainty off-set value
- obs interpolated at model hours (within ± 1.5 h) and model heights
- uncertainty interpolated assuming a temporal and vertical correlation scale
- spherical assumptions

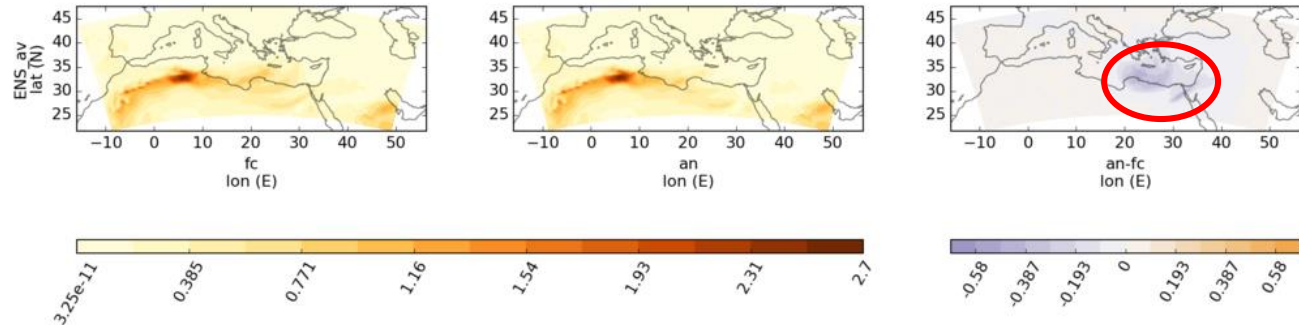
Assimilation of lidar observations: East Mediterranean case study, April 2017

mean ensemble forecast mean ensemble analysis increments

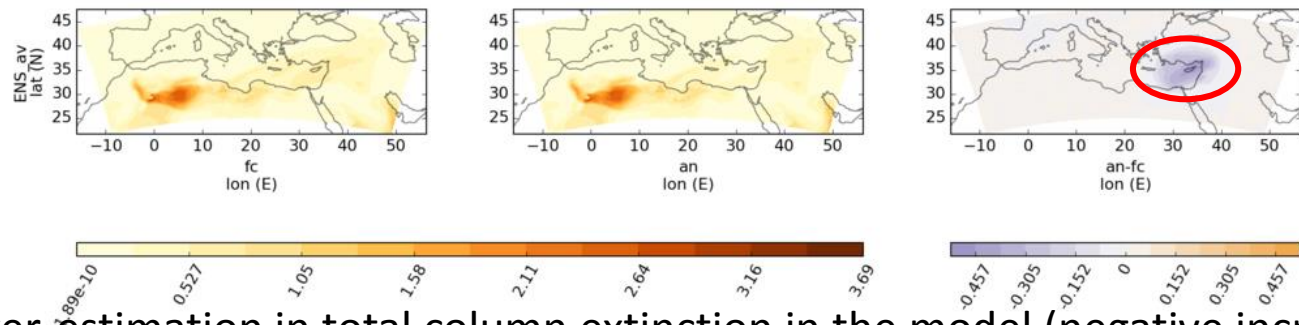
April 19 2017



April 20 2017



April 21 2017

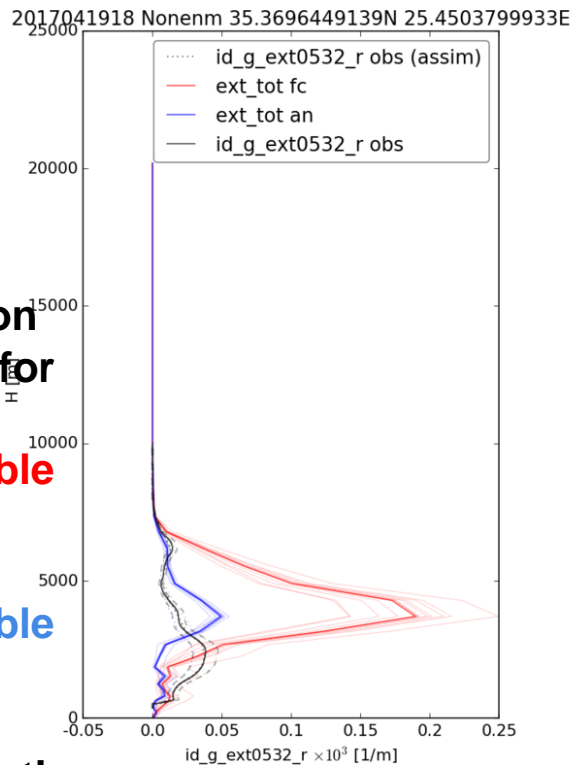


Correction of an over-estimation in total column extinction in the model (negative increments)

Assimilation of lidar observations: East Mediterranean case study, April 2017

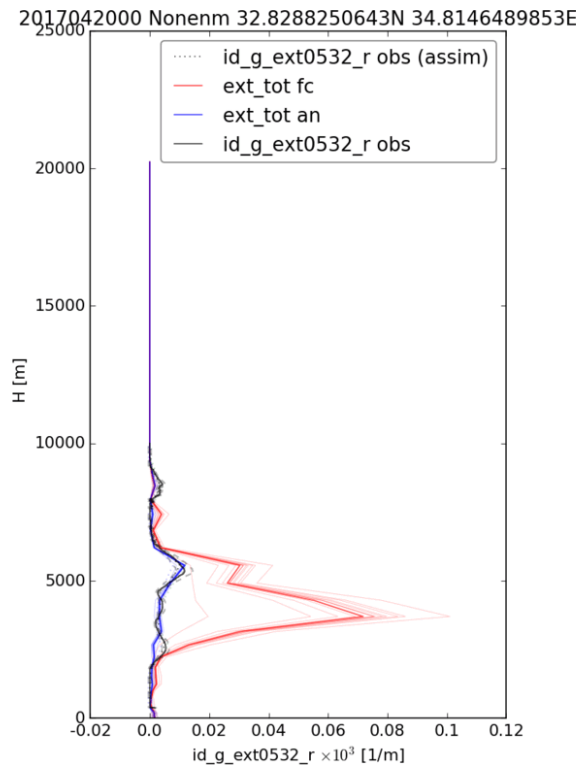
Finokalia

April 19 at 18 UTC



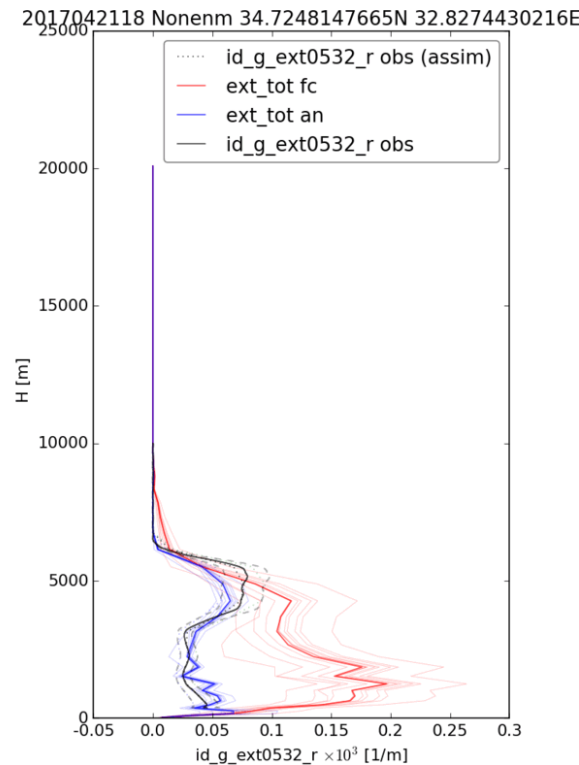
Haifa

April 20 at 0 UTC



Limassol

April 21 at 18 UTC



- An overall correction of a model over-estimation of the total column extinction
- Assimilated observations are able to correct in most cases the plume height

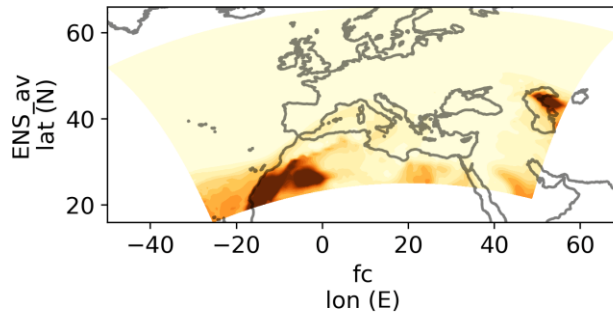
Assimilation of lidar observations: ACTRIS summer campaign, July 2012

Observations: Dust profiles derived from measurements taken during the ACTRIS summer 2012 campaign from three EARLINET stations: Bucharest, Granada, and Potenza. SCC standard products post-processed by **CNR-IMAA**

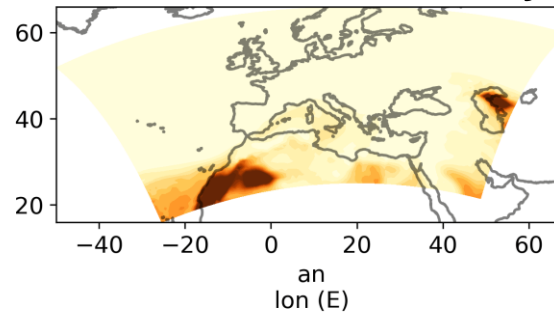
Simulations and DA settings:

0.66° x 0.66° x 40 levels, inflation of ensemble covariance matrix, 1h analysis time resolution, obs interpolated to model hours (within ± 30 min), error statistics estimated assuming a temporal and vertical correlation scale, non-spherical assumption for the calculation of extinction efficiency factors

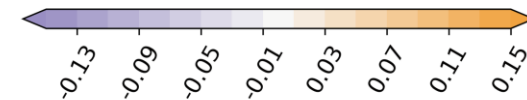
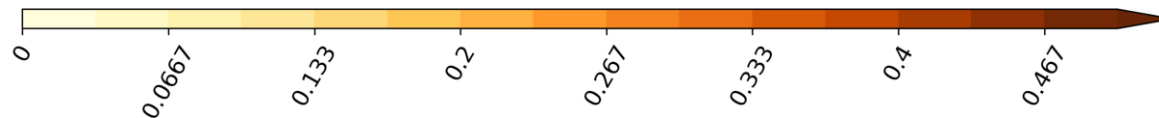
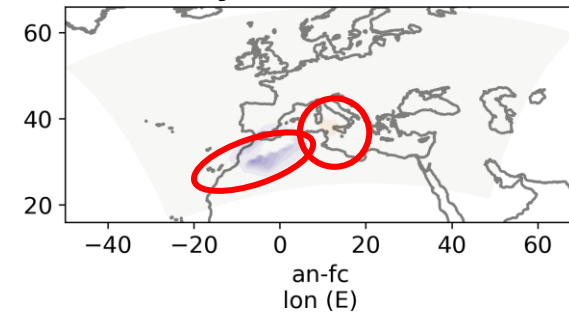
mean ensemble forecast



mean ensemble analysis



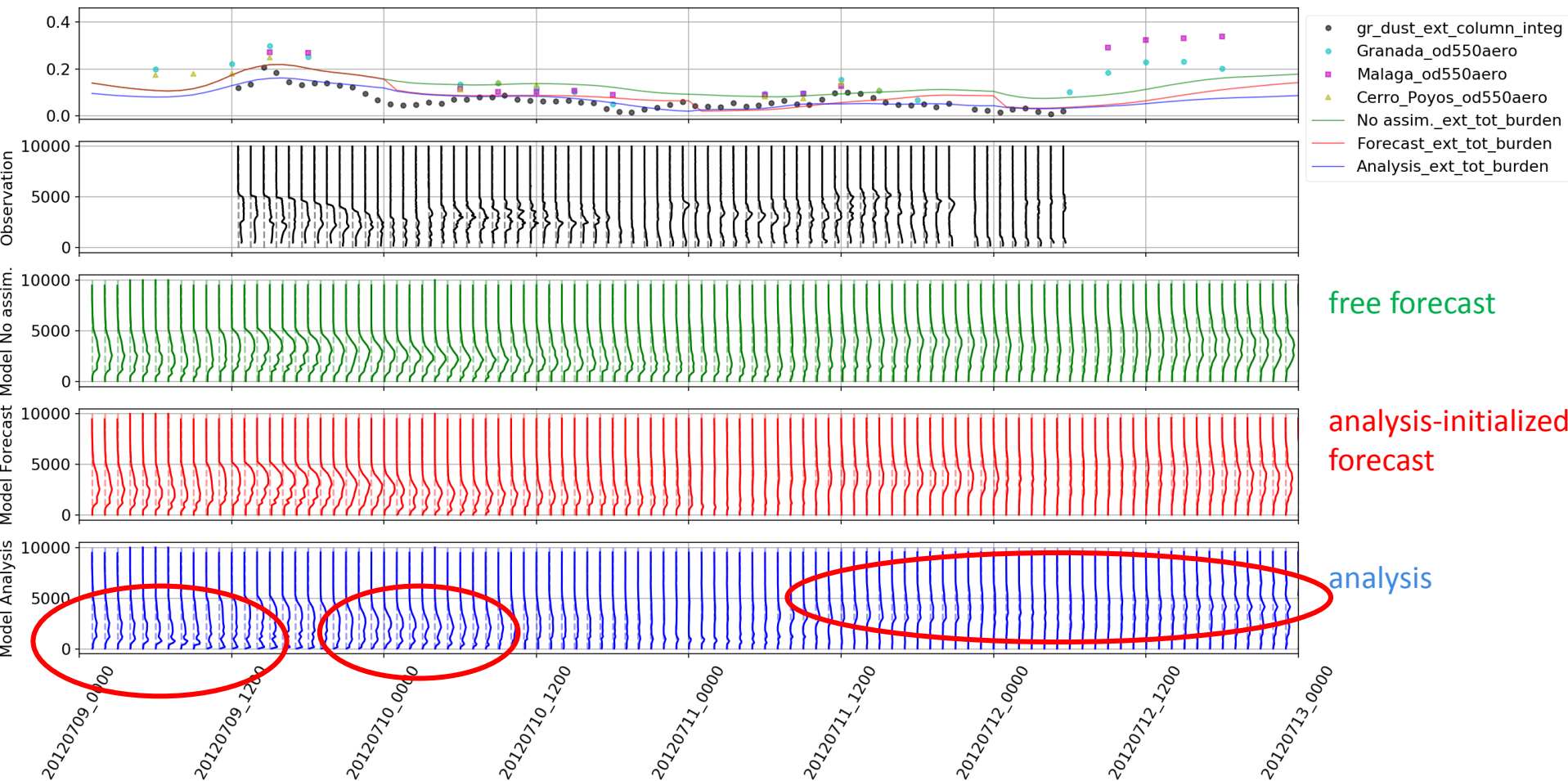
analysis increments



- Correction of an overestimation in AOD in Northern Africa (negative values of increments) and, at a lower extent, of an underestimation in AOD over the Sea of Sicily and Tyrrhenian Sea.
- The analysis corrections are relatively small in terms of AOD. However, lidar observations are able to constrain the vertical structure of the dust plume

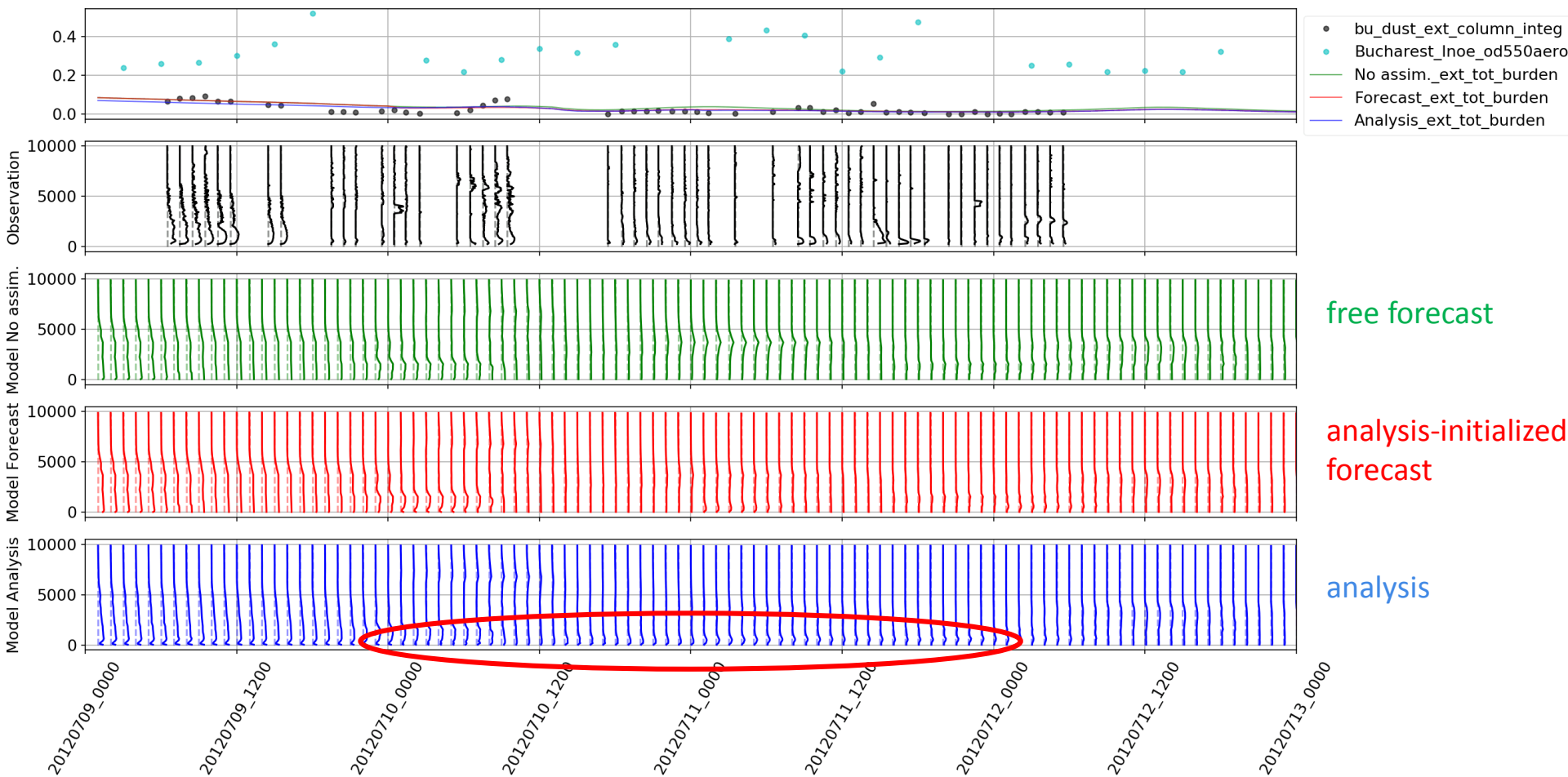
Assimilation of lidar observations: ACTRIS summer campaign, July 2012

Granada



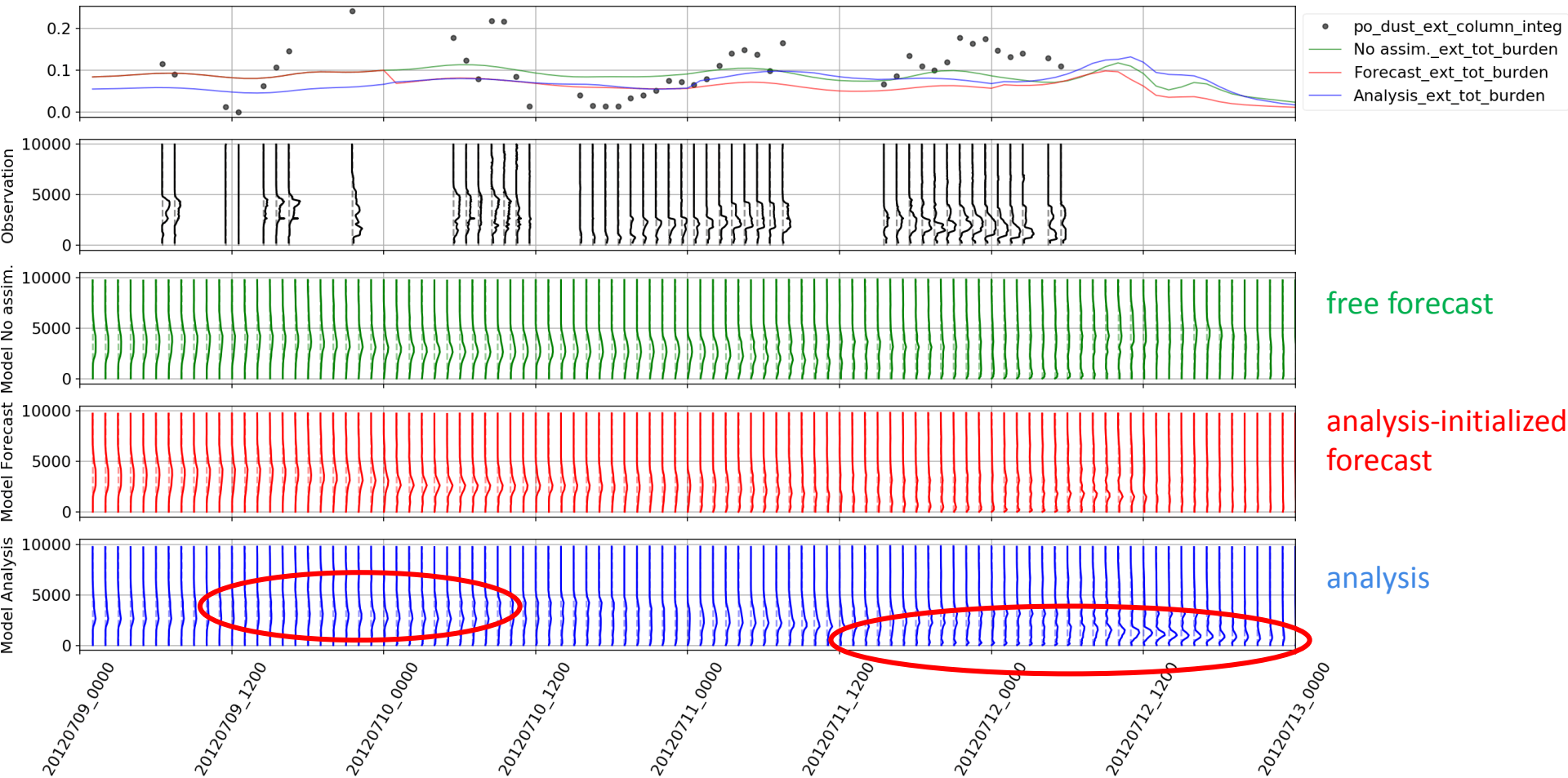
Assimilation of lidar observations: ACTRIS summer campaign, July 2012

Bucharest INOE



Assimilation of lidar observations: ACTRIS summer campaign, July 2012

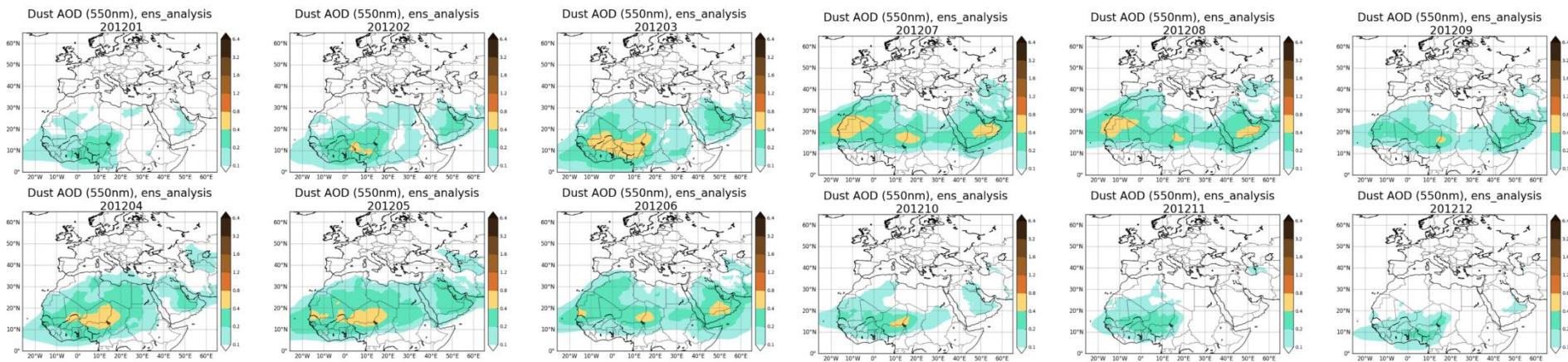
Potenza



ACTRIS data for dust reanalysis validation: DustClim Project (2017-2020)

Produce a **high resolution dust reanalysis** for Northern Africa, Middle East and Europe covering the satellite era of quantitative aerosol information, and develop **dust-related services** tailored to specific socio-economic sectors

Monthly dust analyses for 2012



DustClim



European Research Area
for Climate Services



AEMet
Agencia Estatal de Meteorología



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**EXCELENCIA
SEVERO
OCHOA**

Thanks to the people taking
measurements, maintaining
sites, making retrievals and
observation products



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